Funding Source
WBS: AIST (430728.02.05.02.08)

Diagnosing the Nature of Land-Atmosphere Coupling: A Case Study of Dry/Wet Extremes

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Land-atmosphere (L-A) interactions play a critical role in determining the diurnal evolution of land surface and planetary boundary layer (PBL) temperature and moisture states and fluxes. In turn, these interactions regulate the strength of the connection between surface moisture and precipitation in a coupled system. To address deficiencies in numerical weather prediction and climate models due to improper treatment of L-A interactions, recent studies have focused on development of diagnostics to quantify the strength and accuracy of the land-PBL coupling at the process-level. In this study, a diagnosis of the nature and impacts of local land-atmosphere coupling (LoCo) during dry and wet extreme conditions is presented using a combination of models and observations during the summers of 2006-7 in the U.S. Southern Great Plains. Specifically, the Weather Research and Forecasting (WRF) model has been coupled to NASA's Land Information System (LIS), which provides a flexible and high-resolution representation and initialization of land surface physics and states. A range of diagnostics exploring the links and feedbacks between soil moisture and precipitation are examined for the dry/wet regimes of this region, along with the behavior and accuracy of different land-PBL scheme couplings under these conditions. In addition, we examine the impact of improved specification of land surface states, anomalies, and fluxes that are obtained through the use of a new optimization and uncertainty module in LIS, on the L-A coupling in WRF forecasts. Results demonstrate how LoCo diagnostics can be applied to coupled model components in the context of their integrated impacts on the process-chain connecting the land surface to the PBL and support of hydrological anomalies.

Abstract ID#: 196804
Password: 992638
Final Paper #: J13.2
Program Selection: 26th Conference on Hydrology
Topic Selection: 13. Land Surface-Atmosphere Interactions II (Joint between the 26th Conference on Hydrology and the 24th Conference on Climate Variability and Change)
Title: Diagnosing the Nature of Land-Atmosphere Coupling: A Case Study of Dry/Wet Extremes
Presentation Format: Oral
Paper Submitted by a Student: N
Paper Entered in Competition, if Appropriate: Y